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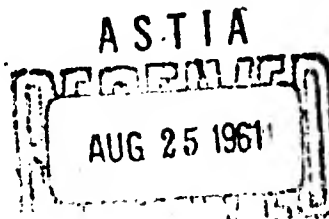
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QUARTERMASTER RESEARCH & ENGINEERING COMMAND
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TECHNICAL REPORT
EP-148

PHYSIOLOGICAL RESPONSE CHANGES OF MEN
ATTRIBUTABLE TO BODY ARMOR, SUN, AND WORK
IN A NATURAL DESERT ENVIRONMENT
(INCLUDING NEGRO-WHITE DIFFERENCES)

XEROX



QUARTERMASTER RESEARCH & ENGINEERING CENTER
ENVIRONMENTAL PROTECTION RESEARCH DIVISION

JUNE 1961

NATICK, MASSACHUSETTS

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<p>AD- Div. 24 Accession No.</p> <p>Quartermaster Research & Engineering Center, Natick, Mass.</p> <p>PHYSIOLOGICAL RESPONSE CHANGES OF MEN ATTRIBUTABLE TO BODY ARMOR, SUN, AND WORK IN A NATURAL DESERT ENVIRONMENT (UNCLASSIFIED REPORT SP-145) (See 1951)</p> <p>Hanson, 14 pp. (Technical Report SP-145) (See 1951)</p> <p>Sweat production, rectal temperature and pulse rate were measured over a 24-consecutive-day period on 12 men (6 white and 6 negro) in both a natural and a modified (shaded) desert environment. These individuals were used to determine the effect of wearing body armor, sun, and exercise, and to compare physiological responses of fair-skinned and dark-skinned subjects.</p> <p>When an individual worked in body armor, and exercised in a natural hot-dry desert environment, significant increases in sweat production, rectal temperature and pulse rate occurred.</p> <p>When an individual was exposed to the sun, significant increases in sweat production occurred.</p> <p>When an individual exercised, significant increases in sweat production, rectal temperature and pulse rate occurred.</p> <p>Heat tolerance of fully-clothed negro and white individuals was about equal in natural hot-dry surroundings.</p>	<p>UNCLASSIFIED</p> <p>Stress (Physiology) 1. Body armor 2. Body temperature 3. Body temperature 4. Climatic factors 5. Heat tolerance 6. Military research 7. Physiology 8. Hanson, Harold E. 9. Title 10. Series</p>	<p>AD- Div. 24 Accession No.</p> <p>Quartermaster Research & Engineering Center, Natick, Mass.</p> <p>PHYSIOLOGICAL RESPONSE CHANGES OF MEN ATTRIBUTABLE TO BODY ARMOR, SUN, AND WORK IN A NATURAL DESERT ENVIRONMENT (UNCLASSIFIED REPORT SP-145) (See 1951)</p> <p>Hanson, 14 pp. (Technical Report SP-145) (See 1951)</p> <p>Sweat production, rectal temperature and pulse rate were measured over a 24-consecutive-day period on 12 men (6 white and 6 negro) in both a natural and a modified (shaded) desert environment. These individuals were used to determine the effect of wearing body armor, sun, and exercise, and to compare physiological responses of fair-skinned and dark-skinned subjects.</p> <p>When an individual worked in body armor, and exercised in a natural hot-dry desert environment, significant increases in sweat production, rectal temperature and pulse rate occurred.</p> <p>When an individual was exposed to the sun, significant increases in sweat production occurred.</p> <p>When an individual exercised, significant increases in sweat production, rectal temperature and pulse rate occurred.</p> <p>Heat tolerance of fully-clothed negro and white individuals was about equal in natural hot-dry surroundings.</p>	<p>UNCLASSIFIED</p> <p>Stress (Physiology) 1. Body armor 2. Body temperature 3. Body temperature 4. Climatic factors 5. Heat tolerance 6. Military research 7. Physiology 8. Hanson, Harold E. 9. Title 10. Series</p>
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Quartermaster Research & Engineering Center
Natick, Massachusetts

ENVIRONMENTAL PROTECTION RESEARCH DIVISION

Technical Report
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PHYSIOLOGICAL RESPONSE CHANGES OF MEN ATTRIBUTABLE TO
BODY ARMOR, SUN, AND WORK IN A NATURAL DESERT
ENVIRONMENT (INCLUDING NEGRO-WHITE DIFFERENCES)

Harold E. Hanson
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Functional Performance Branch

Project No.
7X83-01-009

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FOREWORD

TO MAINTAIN HIMSELF AND OPERATE IN A HOT-DRY ENVIRONMENT, MAN MUST SECRETE AND EVAPORATE SWEAT TO DISSIPATE BODY HEAT. HOWEVER, WHEN CERTAIN PROTECTIVE ITEMS SUCH AS BODY ARMOR ARE WORN, THE EVAPORATIVE RESTRICTION MAY BE SUFFICIENT TO IMPOSE UNDUE STRESS ON THE WEARER AND LIMIT HIS CAPABILITIES. THUS, A PARADOX ARISES: AN ITEM OF NECESSITY PROVIDING PROTECTION TO THE INDIVIDUAL MAY BECOME AN ITEM REDUCING HIS EFFECTIVENESS.

THE IDEAL, OF COURSE, WOULD BE AN ARMORED VEST PROVIDING AMPLE BALLISTIC PROTECTION WHILE NOT REDUCING THE INDIVIDUAL'S EFFECTIVENESS.

HOWEVER, IN MANY CASES, PRACTICALITY DICTATES THAT WE ACCEPT AND USE THE BEST THAT CAN BE PRODUCED WITH ALL OF ITS LIMITATIONS, BUT WE MUST DO SO WITH A FIRM UNDERSTANDING OF THESE LIMITATIONS. THAT WAS THE PURPOSE OF THIS STUDY. THIS REPORT DEALS WITH THE EFFECT OF WEARING BODY ARMOR UNDER A VARIETY OF SITUATIONS IN A HOT-DRY ENVIRONMENT.

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ABSTRACT

SWEAT PRODUCTION, RECTAL TEMPERATURE AND PULSE RATE WERE MEASURED OVER A 24-CONSECUTIVE-DAY PERIOD ON 16 MEN (8 WHITE AND 8 NEGRO) IN BOTH A NATURAL AND A MODIFIED (SHADED) DESERT ENVIRONMENT. THESE INDICES WERE USED TO DETERMINE THE EFFECT OF WEARING BODY ARMOR, SUN, AND EXERCISE, AND TO COMPARE PHYSIOLOGICAL RESPONSES OF PAIRED NEGRO-WHITE SUBJECTS.

WHEN AN INDIVIDUAL DONNED BODY ARMOR, AND EXERCISED IN A NATURAL HOT-DRY DESERT ENVIRONMENT, SIGNIFICANT INCREASES IN SWEAT PRODUCTION, RECTAL TEMPERATURE AND PULSE RATE OCCURRED.

WHEN AN INDIVIDUAL WAS EXPOSED TO THE SUN, SIGNIFICANT INCREASES IN SWEAT PRODUCTION OCCURRED.

WHEN AN INDIVIDUAL EXERCISED, SIGNIFICANT INCREASES IN SWEAT PRODUCTION, RECTAL TEMPERATURE AND PULSE RATE OCCURRED.

HEAT TOLERANCE OF FULLY-CLOTHED NEGRO AND WHITE INDIVIDUALS WAS ABOUT EQUAL IN NATURAL HOT-DRY SURROUNDINGS.

PHYSIOLOGICAL RESPONSE CHANGES OF MEN ATTRIBUTABLE TO BODY
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1. INTRODUCTION

TO MAINTAIN HIMSELF AND OPERATE IN A HOT-DRY ENVIRONMENT, MAN MUST SECRETE AND EVAPORATE SWEAT TO DISSIPATE BODY HEAT. WHEN THE BODY IS COVERED WITH LIGHTWEIGHT CLOTHING, SOME INTERFERENCE WITH EVAPORATION OF SWEAT MAY OCCUR, BUT AT REST AND UP TO AT LEAST MODERATE ACTIVITY LEVELS, THE EVAPORATIVE RESTRICTION IS COMPENSATED FOR BY THE ENVIRONMENTAL PROTECTION AFFORDED BY THE CLOTHING.⁽¹⁾ DURING REST IN A HOT-DRY NATURAL ENVIRONMENT A REDUCTION OF 28% OR 250 GRAMS PER HOUR IN SWEAT PRODUCTION IS ATTRIBUTABLE TO CLOTHING. EVEN DURING MODERATE ACTIVITY LEVELS, SWEAT PRODUCTION OF CLOTHED INDIVIDUALS IS MAINTAINED BELOW THAT OF A CORRESPONDING NUDE COMPANION. HOWEVER, WHEN CERTAIN PROTECTIVE ITEMS SUCH AS BODY ARMOR ARE WORN, THE EVAPORATIVE RESTRICTION MAY BE SUFFICIENT TO IMPOSE UNDUE STRESS ON THE WEARER AND SERIOUSLY LIMIT HIS CAPABILITIES.

VAUGHAN ET AL⁽²⁾ HAVE SHOWN THAT SWEAT PRODUCTION IS SIGNIFICANTLY INCREASED WHEN BODY ARMOR IS WORN UNDER NATURAL DESERT CONDITIONS. THEIR SUBJECTS FUNCTIONED WITHOUT EXCESSIVE PHYSIOLOGICAL STRAIN DURING MODERATE ACTIVITY. GODDARD ET AL⁽³⁾ IN AN ANALYSIS OF REQUIREMENTS AND FEASIBILITY OF HOT-WEATHER BODY ARMOR, SUMMARIZED VARIOUS ARMOR STUDIES CONDUCTED IN ARTIFICIAL AND NATURAL ENVIRONMENTS.

IN CONTINUATION OF PAST STUDIES AND TO DEPICT THE ROLE BODY ARMOR PLAYS AS A STRESS-IMPOSING ELEMENT, AN EXPERIMENT WAS DESIGNED AS FOLLOWS:

- A. TO DETERMINE THE EFFECT OF WEARING BODY ARMOR.
- B. TO DETERMINE THE EFFECT OF SUN ON INDIVIDUALS WEARING BODY ARMOR.
- C. TO DETERMINE THE EFFECT OF EXERCISE ON INDIVIDUALS WEARING BODY ARMOR.
- D. TO DETERMINE (IF ANY) PHYSIOLOGICAL DIFFERENCES BETWEEN PAIRED NEGRO, WHITE SUBJECTS.

2. SUBJECTS AND CONDITIONS

SIXTEEN YOUNG MALE VOLUNTEERS (8 WHITE, 8 NEGRO) WERE SELECTED ON THE BASIS OF HEIGHT, WEIGHT, AND FAT-LEAN BODY MASS RATIO TO FORM THE 8 MATCHED PAIRS OF SUBJECTS.^(4,5) SUBJECT PROFILES AND OTHER PERTINENT DATA ARE GIVEN IN APPENDIX B, TABLES XXI AND XXII.

EACH PAIR OF SUBJECTS FOLLOWED A SPECIFIC SCHEDULE DURING THE CONTINUOUS, 24-DAY STUDY PERIOD. THE OVERALL EXPERIMENTAL PLAN WAS A RANDOMIZED BLOCK WITH REPLICATIONS. THE STUDY ENCOMPASSED 8 CONDITIONS, WITH THE

SUBJECTS REPEATING EACH CONDITION 3 TIMES. THE CONDITIONS, REFLECTING ENVIRONMENT, ATTIRE, ACTIVITY, AND THE CODE FOR EACH CONDITION, ARE AS FOLLOWS:

<u>ENVIRONMENT</u>	<u>CONDITION</u> <u>ATTIRE</u>	<u>ACTIVITY</u>	<u>CODE</u> <u>FOR</u> <u>CONDITION</u>
SHADE (Sh)	CLOTHED (C)	REST (R)	ShCR
SHADE (Sh)	CLOTHED-ARMOR (CA)	REST (R)	ShCAR
SHADE (Sh)	CLOTHED (C)	WORK (W)	ShCW
SHADE (Sh)	CLOTHED-ARMOR (CA)	WORK (W)	ShCAW
SUN (S)	CLOTHED (C)	REST (R)	SCR
SUN (S)	CLOTHED-ARMOR (CA)	REST (R)	SCAR
SUN (S)	CLOTHED (C)	WORK (W)	SCW
SUN (S)	CLOTHED-ARMOR (CA)	WORK (W)	SCAW

ALL SUBJECTS WORE A KHAKI-COLORED, 6-OZ. COTTON POPLIN BUSH COAT-AND-TROUSER COMBINATION, CAP, SHORTS, T-SHIRT, SOCKS, AND BOOTS. THE BODY ARMOR WAS THE 12-PLY STANDARD TYPE, GREEN OUTER FABRIC COVERING, AND WEIGHED APPROXIMATELY 8 POUNDS (ARMOR, BODY, FRAGMENTATION - PROTECTIVE - UPPER TORSO. M-1952A). THIS TYPE OF ARMOR IS WORN VEST-FASHION AND COVERS THE TORSO, OR APPROXIMATELY 25% OF THE BODY SURFACE AREA.

SHADE WAS PROVIDED BY USING A 120 x 40 FOOT TENT WITHOUT SIDEWALLS. THE CENTER WAS 18 FEET ABOVE THE GROUND, AND THE EAVES 8 FEET ABOVE THE GROUND.

TWO 264-FOOT RECTANGULAR WALKING COURSES WERE LAID OUT, ONE INSIDE THE TENT AND ANOTHER IN THE SUN ADJACENT TO THIS AREA. SUBJECTS TRAVERSED A COURSE ONCE EACH MINUTE, THUS ESTABLISHING A WALKING SPEED OF 3 MILES PER HOUR.

SUBJECTS RESTING IN THE SHADE WERE SEATED IN CHAIRS INSIDE THE TENT, 20 FEET FROM THE WINDWARD END. SUBJECTS RESTING IN THE SUN WERE SEATED, ADJACENT TO THE TENT, IN THE SAME MANNER.

3. EXPERIMENTAL PROCEDURES

BEFORE BEGINNING AN EXPERIMENTAL DAY, ALL SUBJECTS, DRESSED IN SHORTS, RECLINED ON CANVAS COTS FOR 1 HOUR IN THE QUARTERS TENT LOCATED NEARBY. AFTER THAT, AT 5-MINUTE INTERVALS, PAIRS OF SUBJECTS ENTERED AN 85°F

AIR-CONDITIONED LABORATORY BUILDING. EACH SUBJECT WAS WEIGHED NUDE ON A BALANCE ACCURATE TO ± 10 GRAMS. RECTAL TEMPERATURE WAS TAKEN BY MEANS OF A CLINICAL THERMOMETER, WHICH REMAINED INSERTED FOR 3 MINUTES. THE SUBJECT THEN DRESSED HIS PARTICULAR ENSEMBLE FOR THE DAY'S EXPOSURE (THAT IS, EITHER THE UNIFORM OR THE UNIFORM-AND-ARMOR COMBINATION) AND WAS WEIGHED AGAIN. THE SUBJECTS, IN PAIRS, THEN PROCEEDED TO THE TEST AREA, ABOUT 50 FEET FROM THE LABORATORY BUILDING, AND BEGAN THEIR SCHEDULE FOR THE DAY. RESTING SUBJECTS REMAINED RELATIVELY INACTIVE, READING OR CONVERSING WITH A COMPANION; EXERCISING SUBJECTS WALKED AT A RATE OF 3 MILES PER HOUR. THE EXPOSURE LASTED FOR 2 HOURS; AT THE END OF THIS TIME PULSE RATES AND FINAL RECTAL TEMPERATURES WERE TAKEN. SUBJECTS THEN RETURNED TO THE LABORATORY WHERE FINAL CLOTHED AND NUDE WEIGHTS WERE TAKEN. THIS COMPLETED THE EXPERIMENTAL DAY.

WATER, CHILLED IN CANTEENS, WAS ALLOWED WHENEVER THE SUBJECT REQUESTED IT. THE QUANTITY CONSUMED WAS DETERMINED BY WEIGHING THE SUBJECT'S CANTEENS AT THE BEGINNING AND END OF EACH EXPERIMENTAL DAY.

"PULSE RATES" WERE DETERMINED BY WRIST PALPATION, COUNTING FOR 20 SECONDS AND MULTIPLYING THIS VALUE BY 3 TO OBTAIN THE RATE PER MINUTE. "SWEAT PRODUCTION" IS THE DIFFERENCE BETWEEN THE INITIAL AND FINAL NUDE WEIGHTS PLUS THE CORRECTION FOR WATER CONSUMED. "SWEAT EVAPORATION" IS THE DIFFERENCE BETWEEN THE INITIAL AND FINAL CLOTHED WEIGHTS PLUS THE CORRECTION FOR WATER CONSUMED. ALL SUBJECTS WERE QUARTERED IN TENTS AND, WITH THE EXCEPTION OF MEALTIME, LIVED UNDER NATURAL DESERT CONDITIONS FOR THE DURATION OF THE EXPERIMENT.

4. METEOROLOGICAL OBSERVATIONS

METEOROLOGICAL DATA WERE FURNISHED THE EXPERIMENTAL TEAM DAILY BY THE U.S. ARMY SIGNAL CORPS METEOROLOGICAL TEAM NO. 1 WHOSE STATION WAS LOCATED ABOUT 1 1/2 MILE FROM THE TEST AREA. SUPPLEMENTAL DATA WERE RECORDED IN THE IMMEDIATE TEST AREA. SUMMARIES OF THESE DATA ARE GIVEN IN TABLE I.

DRY BULB TEMPERATURE GIVEN IN THE SUPPLEMENTAL DATA WAS TAKEN FROM A MERCURY THERMOMETER SUSPENDED ABOUT 3 1/2 FEET ABOVE THE GROUND INSIDE THE LARGE TENT. WINDSPEEDS WERE TAKEN AT 4-FOOT LEVELS, WITH ANEMOMETER NO. 1 LOCATED IN AN OPEN AREA AND ANEMOMETER NO. 2 LOCATED IN THE CENTER OF THE TENT. GLOBE TEMPERATURES WERE TAKEN 4 FEET ABOVE THE GROUND.

5. ANALYSIS AND DISCUSSION OF THE EFFECT OF BODY ARMOR, SUN, AND EXERCISE

A. THE EFFECT OF BODY ARMOR

THE EFFECT OF BODY ARMOR HAS BEEN DETERMINED BY TAKING THE DIFFERENCES IN SWEAT PRODUCTION, SWEAT EVAPORATION, FINAL RECTAL TEMPERATURE, RISE IN RECTAL TEMPERATURE, AND FINAL PULSE RATE OF INDIVIDUALS WITH AND WITHOUT BODY ARMOR.

A SUMMARY OF THESE DIFFERENCES (EXTRACTED FROM TABLES IX - XVI, APPENDIX A) IS GIVEN IN TABLE II AND III.

TABLE I
SUMMARY OF METEOROLOGICAL OBSERVATIONS
(BY METEOROLOGICAL TEAM NO. 1)

	MEAN	(RANGE)
DRY BULB (°F)	101.7	(89.0 - 112.8)
RELATIVE HUMIDITY (%)	10.8	(4 - 25)
WINDSPEED (MPH)	9.8	(6 - 14)
SOLAR RADIATION (KG CAL/M ²)	917	(810 - 966)

SUPPLEMENTAL DATA

TEMPERATURE (°F)

DRY BULB	103	(90 - 114)
BLACK GLOBE)	127	(116 - 146)
WHITE GLOBE) SUN	113	(103 - 127)
BLACK GLOBE)	110	(101 - 126)
WHITE GLOBE) SHADE	108	(99 - 123)

WINDSPEED (MPH)

ANEMOMETER #1	8.6	(3.3 - 13)
ANEMOMETER #2	7.7	(3.0 - 13.8)

TABLE II
EFFECT OF WEARING BODY ARMOR: INCREASES IN SWEAT PRODUCTION
AND EVAPORATION IN GRAMS/2-HOUR EXPOSURE

CONDITION	SWEAT PRODUCTION	% CHANGE	SWEAT EVAPORATION	% CHANGE
SHCAR - SHC ¹	58	6.2	46	5.8
SCAR - SCP ²	142	11.1	74	6.8
SHCAW - SHCW ³	285*	14.9	72	4.4
SCAW - SCW ⁴	402*	18.3	28	1.4

*SIGNIFICANT INCREASES

1, 2, 3, 4 - SEE FOOTNOTES UNDER TABLE III.

TABLE III
EFFECT OF WEARING BODY ARMOR: INCREASES IN FINAL RECTAL
TEMPERATURE, RISE IN RECTAL TEMPERATURE AND FINAL PULSE
RATE/2-HOUR EXPOSURE

CONDITION	CHANGE IN FINAL RECTAL TEMP. (°F)	CHANGE IN RECTAL TEMP. RISE (°F)	PULSE RATE CHANGE	% CHANGE
SHCAR - SHCR ¹	-.05	-.05	0.4	0.6
SCAR - SCR ²	.13	.046	0.3	0.4
SHCAW - SHCW ³	.18	.225	8.9*	8.0
SCAW - SCW ⁴	.34*	.300*	9.4*	8.0

*SIGNIFICANT INCREASES
THE EFFECT OF ARMOR:

¹ IN THE SHADE AT REST
² IN THE SUN AT REST

³ IN THE SHADE EXERCISING
⁴ IN THE SUN EXERCISING

IT HAS BEEN STATED THAT STRESS IMPOSED BY ARMOR IS THE RESULT OF INTER-
FERENCE WITH EVAPORATION OF SWEAT. (2,3) A COMPARISON OF SWEAT PRODUCTION
AND EVAPORATION, GIVEN IN TABLE II, SUPPORTS THIS THEORY. ALTHOUGH SWEAT
EVAPORATION OF INDIVIDUALS WEARING ARMOR WAS SLIGHTLY ELEVATED (28 - 74
GRAMS) COMPARED TO THAT OF INDIVIDUALS NOT WEARING ARMOR, IT WAS ACHIEVED
ONLY VIA HIGHER PRODUCTION LEVELS (58 - 402 GRAMS). SWEAT PRODUCTION
PROGRESSIVELY INCREASED WITH EXPOSURE "SHADE TO SUN" OR "REST TO EXERCISE"
WHILE EVAPORATION ESSENTIALLY DECREASED. THE INCREASED SWEAT PRODUCTION
WAS ABSORBED BY THE CLOTHING AND CEASED TO BE A MEDIUM OF HEAT DISSIPATION
FROM THE BODY VIA EVAPORATION. IN ADDITION, RECTAL TEMPERATURE INCREASES
PARALLELED SWEAT PRODUCTION, BECOMING SIGNIFICANTLY HIGHER DURING EXERCISE
IN THE SUN. PULSE RATES SIGNIFICANTLY INCREASED DURING EXERCISE IN BOTH
THE SHADE OR SUN. ESSENTIALLY, THESE INCREASES IN SWEAT PRODUCTION, RECTAL
TEMPERATURE AND PULSE RATE REFLECT AN INCREASED HEAT LOAD IMPOSED BY BODY
ARMOR AS A RESULT OF EVAPORATIVE INTERFERENCE. DURING MODERATE ACTIVITY
(WALKING 3 MPH) THE HEAT LOAD IMPOSED BY BODY ARMOR, ALTHOUGH NOT EXCESSIVE,
IS SUFFICIENT TO SIGNIFICANTLY INCREASE SWEAT PRODUCTION, RECTAL TEMPERA-
TURE AND PULSE RATE.

B. THE EFFECT OF SUN ON INDIVIDUALS WITH AND WITHOUT BODY ARMOR

THE EFFECT OF SUN ON INDIVIDUALS WITH AND WITHOUT BODY ARMOR HAS
BEEN DETERMINED BY TAKING THE DIFFERENCES IN SWEAT PRODUCTION, EVAPORATION,
RECTAL TEMPERATURE, AND PULSE RATE OF INDIVIDUALS EXPOSED IN THE SHADE AND
IN THE SUN.

A SUMMARY OF THESE DIFFERENCES (EXTRACTED FROM TABLES IX - XVI, APPEN-
DIX A) IS GIVEN IN TABLES IV AND V.

TABLE IV
EFFECT OF SUN: INCREASES IN SWEAT PRODUCTION AND EVAPORATION
IN GRAMS/2-HOUR EXPOSURE

CONDITION	SWEAT PRODUCTION	% INCREASE	SWEAT EVAPORATION	% INCREASE
SCR - SHCR ¹	345*	37.0	294*	36.8
SCAR - SHCAR ²	429*	43.3	322*	38.1
SCW - SHCW ³	289*	15.1	309*	18.7
SCAW - SHCAW ⁴	406*	18.5	265*	15.4

*SIGNIFICANT INCREASES

1, 2, 3, 4 - SEE FOOTNOTES UNDER TABLE V.

TABLE V
EFFECT OF SUN: INCREASES IN RECTAL TEMPERATURE AND PULSE
RATE/2-HOUR EXPOSURE

CONDITION	CHANGE IN FINAL RECTAL TEMP. (°F)	CHANGE IN RECTAL TEMP. RISE (°F)	PULSE RATE CHANGE	% CHANGE
SCR - SHCR ¹	.22	.208	3.4	5.0
SCAR - SHCAR ²	.40*	.304*	3.3	4.8
SCW - SHCW ³	.13	.163	6.5*	5.9
SCAW - SHCAW ⁴	.29*	.238	7.0*	5.8

*SIGNIFICANT INCREASES

THE EFFECT OF SUN:

- 1 INDIVIDUAL RESTING WITHOUT ARMOR
2 INDIVIDUAL RESTING WITH ARMOR

- 3 INDIVIDUAL EXERCISING W/O ARMOR
4 INDIVIDUAL EXERCISING WITH ARMOR

WHEN AN INDIVIDUAL IS EXPOSED TO THE SUN, SIGNIFICANT INCREASES IN SWEAT PRODUCTION AND EVAPORATION OCCUR. THESE INCREASES IN SWEAT PRODUCTION WERE OF GREATER MAGNITUDE WHEN ARMOR WAS WORN, BUT CORRESPONDED TO LOWER NET EVAPORATIVE RATE INCREASES THAN WERE FOUND WITH INDIVIDUALS WITHOUT ARMOR. RECTAL TEMPERATURE AND PULSE RATE ALSO INCREASED WITH EXPOSURE TO SUN. HOWEVER, RECTAL TEMPERATURE INCREASED SIGNIFICANTLY ONLY WHEN ARMOR WAS WORN. PROBABLY THIS SIGNIFICANT INCREASE IS ATTRIBUTABLE TO THE EVAPORATIVE RESTRICTION IMPOSED BY ARMOR. PULSE RATE INCREASED SIGNIFICANTLY, IRRESPECTIVE OF ARMOR, ONLY DURING EXERCISE.

NEGLECTING THE SLIGHT INCREASE IN RECTAL TEMPERATURE, THE SOLAR HEAT LOAD HAS BEEN COMPUTED BY TAKING THE LATENT HEAT OF EVAPORATION AS 0.58 KG CAL/GRAM OF SWEAT EVAPORATED. ALSO, ALLOWANCE SHOULD BE MADE FOR THE EVAPORATIVE INTERFERENCE OF ARMOR, ESPECIALLY DURING EXERCISE. THESE COMPUTED VALUES ARE GIVEN IN TABLE VI.

TABLE VI
SOLAR HEAT LOAD (IN KG CAL)

CONDITION	2-HOURS	1-HOUR
SCR - SHCR ¹	170	85
SCAR - SHCAR ²	187	94
SCW - SHCW ³	179	90
SCAW - SHCAW ⁴	154	77

1, 2, 3, 4 - SEE FOOTNOTES UNDER TABLE V.

HENSCHEL AND HANSON⁽¹⁾, WORKING UNDER A SIMILAR EXPERIMENTAL SITUATION, HAVE SHOWN THAT THE ENVIRONMENTAL HEAT GAINS OF CLOTHED AND NUDE SUBJECTS AT REST AND EXERCISING RANGE FROM 120 TO 200 KG CAL/HOUR. THEY REPORT THE ENVIRONMENTAL HEAT GAIN OF ACTIVE AND INACTIVE SUBJECTS, CLOTHED IN LIGHTWEIGHT ENSEMBLES, TO BE ABOUT 120 KG CAL/HOUR. IN THE PRESENT STUDY, ENVIRONMENTAL HEAT GAINS OF INDIVIDUALS WITHOUT ARMOR, DURING REST AND EXERCISE, WERE 85 AND 90 KG CAL, RESPECTIVELY. ALTHOUGH THESE VALUES ARE SOMEWHAT LOWER THAN THOSE REPORTED ABOVE, IT IS FELT THAT A GENERAL AGREEMENT EXISTS BETWEEN THE DATA OF THESE 2 EXPERIMENTS.

SUBJECTS USED BY HENSCHEL AND HANSON WEIGHED ABOUT 76 KILOGRAMS OR ABOUT 5 KILOGRAMS MORE THAN THOSE IN THE PRESENT STUDY. THEIR SUBJECTS WERE CLOTHED IN 5-OZ. POPLIN GREEN-COLORED SHIRT-TROUSER ENSEMBLES AND THOSE OF THE PRESENT STUDY IN A 6-OZ. POPLIN KHAKI-COLORED, BELTED, BUSH COAT-TROUSER ENSEMBLE. BRECKENRIDGE⁽⁷⁾ HAS SHOWN THAT INDIVIDUALS WEARING UNIFORMS FABRICATED FROM THE SAME MATERIAL, WHICH DIFFERED ONLY IN COLOR, SECRETE 5% MORE SWEAT IN A GREEN ENSEMBLE THAN A KHAKI-COLORED ENSEMBLE. PROBABLY THE DIFFERENCES IN THE SUBJECTS' WEIGHTS, THE ENSEMBLE COLOR, AND THE DESIGN OF THE ENSEMBLES ACCOUNT FOR THE VARIATIONS IN RESULTS BETWEEN THE 2 STUDIES.

C. THE EFFECT OF EXERCISE ON INDIVIDUALS WITH AND WITHOUT BODY ARMOR

THE EFFECT OF EXERCISE ON INDIVIDUALS WITH AND WITHOUT BODY ARMOR HAS BEEN DETERMINED BY TAKING THE DIFFERENCES IN SWEAT PRODUCTION, SWEAT EVAPORATION, RECTAL TEMPERATURE, AND PULSE RATE BETWEEN RESTING AND EXERCISING INDIVIDUALS. A SUMMARY OF THESE DIFFERENCES (EXTRACTED FROM TABLES IX - XVI, APPENDIX A) IS GIVEN IN TABLES VII AND VIII. ALL DIFFERENCES ARE SIGNIFICANT.

TABLE VII
EFFECT OF EXERCISE: INCREASES IN SWEAT PRODUCTION
AND EVAPORATION IN GRAMS/2-HOUR EXPOSURE

CONDITION	SWEAT PRODUCT. ON	% INCREASE	SWEAT EVAPORATION	% INCREASE
SHCW - SHCR ¹	977	104.7	851	106.4
SCW - SCR ²	921	72.1	866	79.1
SHCAW - SHCAR ³	1204	121.5	877	103.7
SCAW - SCAR ⁴	1181	83.2	820	70.2

1, 2, 3, 4 - SEE FOOTNOTES UNDER TABLE VIII

TABLE VIII
EFFECT OF EXERCISE: INCREASES IN RECTAL TEMPERATURE
AND PULSE RATE/2-HOUR EXPOSURE

CONDITION	CHANGE IN FINAL RECTAL TEMP. (°F)	CHANGE IN RECTAL TEMP. RISE (°F)	PULSE RATE CHANGE	% CHANGE
SHCW - SHCR ¹	.81	.779	42.9	63.1
SCW - SCR ²	.72	.734	46.0	64.4
SHCAW - SHCAR ³	1.04	1.054	51.4	75.1
SCAW - SCAR ⁴	.93	.988	55.1	76.8

THE EFFECT OF WORK

¹ IN THE SHADE WITHOUT ARMOR
² IN THE SUN WITHOUT ARMOR

³ IN THE SHADE WITH ARMOR
⁴ IN THE SUN WITH ARMOR

UNDER ANY WORK CONDITION, SIGNIFICANT INCREASES IN SWEAT PRODUCTION, EVAPORATION, RECTAL TEMPERATURE, AND PULSE RATE OCCURRED OVER THAT OF AN INDIVIDUAL IN A COMPARABLE REST SITUATION. IN GENERAL, IRRESPECTIVE OF ARMOR, INDIVIDUALS EXERCISING IN THE SHADE PRODUCED MORE THAN TWICE THE SWEAT OF A RESTING COUNTERPART. EXERCISING IN THE SUN, SWEAT PRODUCTION WAS 1.7 TO 1.8 TIMES THE RESTING COUNTERPART.

GREATER INCREASES IN PHYSIOLOGICAL RESPONSES OCCURRED WHEN ARMOR WAS WORN, WHICH REFLECTED THE INCREASED HEAT LOAD BEING IMPOSED ON THE WEARER. HOWEVER, SWEAT PRODUCTION AND RECTAL TEMPERATURE INCREASES WERE INVERSELY

RELATED TO ENVIRONMENTAL INTENSITY (SHADE/SUN), WHILE PULSE RATE INCREASES WERE DIRECTLY RELATED. IN GENERAL, THESE DATA ARE IN AGREEMENT WITH A PREVIOUS STUDY⁽¹⁾ REPORTING THE PHYSIOLOGICAL CHANGES OF NUDE AND CLOTHED INDIVIDUALS, ATTRIBUTABLE TO WORK, IN A HOT-DRY ENVIRONMENT.

6. NEGRO-WHITE DIFFERENCES

VARIANCE ANALYSIS OF SWEAT PRODUCTION, SWEAT EVAPORATION AND RECTAL TEMPERATURE REVEALED NO SIGNIFICANT DIFFERENCES BETWEEN THE NEGRO AND WHITE SUBJECTS. THESE DATA, WITH AN ADDITIONAL TABLE OF EARLY MORNING RECTAL TEMPERATURES OF PAIRED NEGRO-WHITE SUBJECTS, BODY COMPOSITION AND SUBJECT PROFILE ARE GIVEN IN APPENDIX B.

IT IS CONCLUDED FROM THESE DATA THAT THE HEAT TOLERANCE OF FULLY CLOTHED NEGRO AND WHITE SUBJECTS IS ABOUT EQUAL, WHEN THEY ARE EXPOSED TO A NATURAL HOT-DRY DESERT ENVIRONMENT. IN GENERAL, THIS INFORMATION, WITH THE POSSIBLE EXCEPTION OF SWEAT PRODUCTION, SUPPORTS THE FINDINGS OF BAKER.⁽²⁾

7. SUMMARY

A. BODY ARMOR: WHEN STANDARD BODY ARMOR WAS WORN, AN INCREASE IN SWEAT PRODUCTION OCCURRED OVER THAT OF A COUNTERPART WITHOUT BODY ARMOR. THIS INCREASE BECAME GREATER IN MAGNITUDE AS THE EXPOSURE CONDITION (SHADE-SUN; REST-EXERCISE) INTENSIFIED. DURING REST IN THE SHADE OR SUN, SWEAT PRODUCTION INCREASED 6 TO 11% OR 30 TO 70 GRAMS/HOUR RESPECTIVELY. HOWEVER, DURING EXERCISE SWEAT PRODUCTION INCREASES WERE SIGNIFICANTLY HIGHER THAN THOSE OF THE COUNTERPART NOT WEARING BODY ARMOR. DURING EXERCISE SWEAT PRODUCTION INCREASED 15 TO 18% OR 140 TO 200 GRAMS/HOUR IN THE SHADE AND SUN RESPECTIVELY. SWEAT EVAPORATION, ALTHOUGH INCREASING SLIGHTLY (14 TO 38 GRAMS/HR.), REFLECTED ALMOST AN INVERSE TREND WITH RESPECT TO BOTH INCREASE IN SWEAT PRODUCTION AND CONDITION INTENSITY.

FINAL RECTAL TEMPERATURE CHANGE, IN GENERAL, INCREASED WITH CONDITION INTENSITY AND WAS SIGNIFICANTLY HIGHER DURING EXERCISE IN THE SUN. PULSE RATE INCREASED SIGNIFICANTLY DURING EXERCISE IN BOTH SHADE AND SUN.

THUS, BODY ARMOR WORN BY AN INDIVIDUAL, EXERCISING MODERATELY IN A NATURAL HOT-DRY DESERT ENVIRONMENT, BRINGS ABOUT SIGNIFICANT INCREASES IN SWEAT PRODUCTION, RECTAL TEMPERATURE AND PULSE RATE.

B. SUN: WHEN AN INDIVIDUAL WAS EXPOSED TO THE SUN, RESTING OR EXERCISING, WITH OR WITHOUT BODY ARMOR, SIGNIFICANT INCREASES IN SWEAT PRODUCTION AND EVAPORATION OCCURRED. THE INCREASES IN SWEAT PRODUCTION WERE SLIGHTLY GREATER IN MAGNITUDE WHEN THE SUBJECT WORE ARMOR. THIS REFLECTS THE INCREASED HEAT LOAD IMPOSED BY THE ARMOR. SWEAT PRODUCTION INCREASED 37 TO 43% (170 TO 210 GRAMS/HOUR) DURING REST AND 15 TO 18% (145 TO 200 GRAMS/HOUR) DURING EXERCISE. RECTAL TEMPERATURE AND PULSE RATE ALSO INCREASED SLIGHTLY. HOWEVER, RECTAL TEMPERATURE INCREASED SIGNIFICANTLY ONLY WHEN THE INDIVIDUAL WORE BODY ARMOR AND PULSE RATE INCREASED SIGNIFICANTLY ONLY WHEN THE INDIVIDUAL EXERCISED.

C. EXERCISE: WHEN AN INDIVIDUAL EXERCISED, SIGNIFICANT INCREASES IN SWEAT PRODUCTION, EVAPORATION, RECTAL TEMPERATURE AND PULSE RATE OCCURRED. THESE INCREASES, WITH THE EXCEPTION OF SWEAT EVAPORATION, WERE OF HIGHEST ORDER WHEN ARMOR WAS WORN. SWEAT PRODUCTION AND RECTAL TEMPERATURE INCREASES, IRRESPECTIVE OF ARMOR, WERE HIGHER WHEN THE INDIVIDUAL EXERCISED IN THE SHADE AND PULSE RATES WERE HIGHER DURING EXERCISE IN THE SUN. IN GENERAL, INDIVIDUALS EXERCISING IN THE SHADE PRODUCED MORE THAN TWICE THE SWEAT OF A RESTING COUNTERPART. EXERCISING IN THE SUN, SWEAT PRODUCTION WAS 1.7 TO 1.8 TIMES THE RESTING COUNTERPART.

D. NEGRO-WHITE DIFFERENCE: IT IS CONCLUDED, FROM THE DATA PRESENTED HEREIN, THAT THE HEAT TOLERANCE OF FULLY CLOTHED NEGRO AND WHITE SUBJECTS WAS ABOUT EQUAL, WHEN THEY WERE EXPOSED TO A NATURAL HOT-DRY DESERT ENVIRONMENT.

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APPENDIX A
MEAN PHYSIOLOGICAL DATA, STATISTICAL INFORMATION, AND DIFFERENCES
BETWEEN ALL CONDITIONS

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2. RECTAL TEMPERATURE	12
3. FINAL PULSE RATE	15

APPENDIX A
MEAN PHYSIOLOGICAL DATA, STATISTICAL INFORMATION, AND DIFFERENCES
BETWEEN ALL CONDITIONS

1. SWEAT PRODUCTION AND EVAPORATION

MEAN SWEAT PRODUCTION AND SWEAT EVAPORATION FOR EACH OF THE 8 CONDITIONS ARE GIVEN IN TABLE IX.

TABLE IX
MEAN SWEAT PRODUCTION AND EVAPORATION IN GRAMS
PER 2-HOUR PERIOD

	<u>CONDITION</u>							
	<u>SHCR</u>	<u>SHCAR</u>	<u>SCR</u>	<u>SCAR</u>	<u>SHCW</u>	<u>SHCAW</u>	<u>SCW</u>	<u>SCAW</u>
SWEAT PRODUCTION	933	991	1278	1420	1910	2195	2199	2601
SWEAT EVAPORATION	800	846	1094	1168	1651	1723	1960	1988

VARIANCE ANALYSIS OF SWEAT PRODUCTION AND SWEAT EVAPORATION REVEALED NO SIGNIFICANT DIFFERENCES BETWEEN THE NEGRO AND WHITE SUBJECTS. THEREFORE, IN COMPUTING THE MEAN SWEAT PRODUCTION AND SWEAT EVAPORATION PER CONDITION, DATA FROM THE 2 SUBJECT GROUPS WERE COMBINED.

SCHEFFE'S TEST WAS PERFORMED TO DETERMINE THE CRITICAL INTERVAL BETWEEN THE MEANS PER CONDITION. AN INTERVAL OF 156 GRAMS FOR SWEAT PRODUCTION AND 134 GRAMS FOR SWEAT EVAPORATION IS NECESSARY FOR A SIGNIFICANT DIFFERENCE AT THE 5% LEVEL OF CONFIDENCE.

DIFFERENCES IN SWEAT PRODUCTION AND SWEAT EVAPORATION RELATED TO ALL CONDITIONS ARE GIVEN IN TABLES X AND XI, RESPECTIVELY. IN USING THESE TABLES, A CONDITION STATED ON THE VERTICAL AXIS IS MATCHED AT RIGHT ANGLES TO A CONDITION ON THE HORIZONTAL AXIS. THE VALUE AT THE INTERSECTION OF THE RIGHT ANGLE, SO DETERMINED, REPRESENTS AN INCREASE; OR IF THE REVERSAL OF THIS PROCEDURE IS FOLLOWED, THE VALUE REPRESENTS A DECREASE.

2. RECTAL TEMPERATURE

MEAN INITIAL, FINAL, AND RISE IN RECTAL TEMPERATURE FOR EACH OF THE 8 CONDITIONS ARE GIVEN IN TABLE XII. RATHER THAN ROUND THESE VALUES, THEY HAVE BEEN PRESENTED IN THEIR ORIGINAL COMPUTED FORM.

VARIANCE ANALYSIS OF FINAL, INITIAL, AND RISE IN RECTAL TEMPERATURE REVEALED NO SIGNIFICANT DIFFERENCES BETWEEN THE NEGRO AND WHITE SUBJECTS. THEREFORE, IN COMPUTING THE MEAN FINAL, INITIAL, AND RISE IN RECTAL TEMPERATURE PER CONDITION, DATA FROM THE 2 SUBJECT GROUPS WERE COMBINED.

TABLE X
DIFFERENCES IN SWEAT PRODUCTION BETWEEN CONDITIONS,
VALUES IN GRAMS AND BASED ON MEAN 2-HOUR RATES

CONDITIONS	SCAW	SCW	SHCAW	SHCW	SCAR	SCR	SHCAR
SHCR	1668	1266	1262	977	487	345	58
SHCAR	1610	1208	1204	919	429	287	
SCR	1323	921	917	632	142		
SCAR	1181	779	775	493			
SHCW	691	289	285				
SHCAW	406	4					
SCW	402						

VALUES GREATER THAN 156 GRAMS ARE SIGNIFICANT.

TABLE XI
DIFFERENCES IN SWEAT EVAPORATION BETWEEN CONDITIONS,
VALUES IN GRAMS AND BASED ON MEAN 2-HOUR RATES

CONDITIONS	SCAW	SCW	SHCAW	SHCW	SC	SCR	SHCAR
SHCR	1188	1160	923	851	368	294	46
SHCAR	1142	1114	877	805	322	248	
SCR	894	866	629	557	74		
SCAR	820	792	555	483			
SHCW	337	309	72				
SHCAW	265	237					
SCW	28						

VALUES GREATER THAN 134 GRAMS ARE SIGNIFICANT.

TABLE XII
MEAN FINAL, INITIAL, AND RISE IN RECTAL TEMPERATURE

RECTAL TEMPERATURE	CONDITION							
	SHCR	SHCAR	SCR	SCAR	SHCW	SHCAW	SCW	SCAW
FINAL	99.40	99.35	99.62	99.75	100.21	100.39	100.34	100.68
INITIAL	99.35	99.35	99.36	99.45	99.38	99.33	99.34	99.39
RISE	.052	.002	.260	.306	.831	1.056	.994	1.294

SCHEFFE'S TEST WAS PERFORMED TO DETERMINE THE CRITICAL INTERVAL BETWEEN THE MEANS. AS WOULD BE EXPECTED, NO SIGNIFICANT DIFFERENCES WERE FOUND BETWEEN MEANS PER CONDITION FOR THE INITIAL RECTAL. HOWEVER, SIGNIFICANT DIFFERENCES BETWEEN MEAN FINAL AND MEAN RISE IN RECTAL TEMPERATURES PER CONDITION WERE FOUND. A CRITICAL INTERVAL OF $.25^{\circ}\text{F}$ FOR FINAL RECTAL TEMPERATURE AND $.27^{\circ}\text{F}$ FOR RISE IN RECTAL TEMPERATURE IS REQUIRED FOR A SIGNIFICANT DIFFERENCE AT THE 5% LEVEL OF CONFIDENCE.

DIFFERENCES IN FINAL AND RISE IN RECTAL TEMPERATURE RELATED TO ALL CONDITIONS ARE GIVEN IN TABLES XIII AND XIV.

TABLE XIII
DIFFERENCES IN $^{\circ}\text{F}$ BETWEEN CONDITIONS BASED ON FINAL RECTAL TEMPERATURE (AT THE END OF A 2-HOUR EXPOSURE)

CONDITIONS	SCAW	SCW	SHCAW	SHCW	SCAR	SCR	SHCAR
SHCR	1.28	.94	.99	.81	.35	.22	-.05
SHCAR	1.33	.99	1.04	.86	.40	.27	
SCR	1.06	.72	.77	.59	.13		
SCAR	.93	.59	.64	.46			
SHCW	.47	.13	.18				
SHCAW	.29	.05					
SCW	.34						

VALUES GREATER THAN .25 ARE SIGNIFICANT.

TABLE XIV
DIFFERENCES IN $^{\circ}\text{F}$ BETWEEN CONDITIONS BASED ON RISE IN RECTAL TEMPERATURES (IN 2-HOUR EXPOSURE)

CONDITIONS	SCAW	SCW	SHCAW	SHCW	SCAR	SCR	SHCAR
SHCR	1.242	.942	1.004	.779	.254	.208	-.050
SHCAR	1.292	.992	1.054	.829	.304	.258	
SCR	1.034	.734	.796	.571	.046		
SCAR	.988	.688	.750	.425			
SHCW	.463	.163	.225				
SHCAW	.238	.062					
SCW	.300						

VALUES GREATER THAN .27 ARE SIGNIFICANT.

3- FINAL PULSE RATE

THE MEAN FINAL PULSE RATE FOR EACH OF THE 8 CONDITIONS IS GIVEN IN TABLE XV.

VARIANCE ANALYSIS OF FINAL PULSE RATE REVEALED NO SIGNIFICANT DIFFERENCES BETWEEN NEGRO AND WHITE SUBJECTS. THEREFORE, RATES OF BOTH SUBJECT GROUPS WERE COMBINED AND MEANS PER CONDITION COMPUTED.

SCHFFE'S TEST WAS PERFORMED TO DETERMINE THE CRITICAL INTERVAL BETWEEN THE MEANS PER CONDITION. AN INTERVAL OF 5.7 IS REQUIRED FOR SIGNIFICANCE AT THE 5% LEVEL OF CONFIDENCE.

DIFFERENCES IN FINAL PULSE RATE RELATED TO ALL CONDITIONS ARE GIVEN IN TABLE XVI.

TABLE XV
FINAL PULSE RATE (AT THE END OF A 2-HOUR EXPOSURE)

CONDITION	SHCR	SHCAR	SCR	SCAR	SHCW	SHCAW	SCW	SCAW
RATE	66.0	68.4	71.4	71.7	110.9	119.8	117.4	126.8

TABLE XVI
DIFFERENCES IN FINAL PULSE RATE BETWEEN CONDITIONS
(BEATS/MINUTE)

CONDITIONS	SCAW	SCW	SHCAW	SHCW	SCAR	SCR	SHCAR
SHCR	58.8	49.4	51.8	42.9	3.7	3.4	0.4
SHCAR	58.4	49.0	51.4	42.5	3.3	3.0	
SCR	55.4	46.0	48.4	39.5	0.3		
SCAR	55.1	45.7	48.1	39.2			
SHCW	15.9	6.5	8.9				
SHCAW	7.0	-2.4					
SCW	9.4						

VALUES GREATER THAN 5.7 ARE SIGNIFICANT.

APPENDIX B

SUPPLEMENTAL TABLES: BREAKDOWN OF SWEAT PRODUCTION, SWEAT EVAPORATION AND RECTAL TEMPERATURE/CONDITION; EARLY MORNING RECTAL TEMPERATURE, BODY COMPOSITION AND SUBJECT PROFILE OF 8 WHITE AND 8 NEGRO SUBJECTS

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APPENDIX B
SUPPLEMENTAL TABLES: BREAKDOWN OF SWEAT PRODUCTION, SWEAT EVAPORATION
AND RECTAL TEMPERATURE/CONDITION; EARLY MORNING RECTAL TEMPERATURE,
BODY COMPOSITION AND SUBJECT PROFILE OF 8 WHITE AND 8 NEGRO SUBJECTS

TABLE XVII
SWEAT PRODUCTION AND EVAPORATION FOR 8 NEGROES AND 8 WHITES
UNDER VARIOUS CONDITIONS (IN GRAMS PER 2-HOUR EXPOSURE)

	SHCR	SHCAR	SCR	SCAR	SHCW	SHCAW	SCW	SCAW
<u>SWEAT PRODUCTION</u>								
NEGRO	918	971	1250	1394	1886	2171	2179	2570
WHITE	948	1011	1306	1446	1935	2219	2218	2632
DIFFERENCE*	-30	-40	-56	-52	-49	-48	-39	-62
<u>EVAPORATED SWEAT</u>								
NEGRO	842	801	1153	1093	1725	1663	1974	2016
WHITE	851	799	1183	1096	1721	1639	1946	1961
DIFFERENCE*	-9	+2	-30	-3	+4	+24	+28	+55

* - INDICATES HIGHER SWEAT PRODUCTION OR EVAPORATION FOR THE WHITE.
+ INDICATES HIGHER SWEAT PRODUCTION OR EVAPORATION FOR THE NEGRO.

TABLE XVIII
INITIAL AND FINAL RECTAL TEMPERATURES (°F) FOR 8 NEGROES
AND 8 WHITES UNDER VARIOUS CONDITIONS

	SHCR	SHCAR	SCR	SCAR	SHCW	SHCAW	SCW	SCAW
<u>INITIAL RECTAL TEMPERATURE</u>								
NEGRO	99.4	99.4	99.4	99.5	99.5	99.4	99.5	99.4
WHITE	99.3	99.3	99.3	99.4	99.3	99.2	99.2	99.3
DIFFERENCE*	+0.1	+0.1	+0.1	+0.1	+0.2	+0.2	+0.3	+0.1
<u>FINAL RECTAL TEMPERATURE</u>								
NEGRO	99.5	99.5	99.7	99.9	100.2	100.4	100.4	100.8
WHITE	99.3	99.2	99.6	99.6	100.2	100.4	100.3	100.6
DIFFERENCE*	+0.2	+0.3	+0.1	+0.3	0.0	0.0	+0.1	+0.2

*+ INDICATES HIGHER INITIAL OR FINAL RECTAL TEMPERATURE FOR THE NEGRO.

TABLE XIX
RISE IN RECTAL TEMPERATURE (°F) FOR 8 NEGROES
AND 8 WHITES UNDER VARIOUS CONDITIONS

	SHCR	SHCAR	SCR	SCAR	SHCW	SHCAW	SCW	SCAW
NEGRO	0.1	0.1	0.2	0.3	0.7	1.0	1.0	1.3
WHITE	0.0	0.1	0.3	0.3	0.9	1.2	1.0	1.3
DIFFERENCE*	+0.1	0.0	-0.1	0.0	-0.2	-0.2	0.0	0.0

*+ INDICATES GREATER RISE FOR THE NEGRO.

- INDICATES GREATER RISE FOR THE WHITE.

NOTE: THIS TABLE IS BASED ON A COMPILATION OF ALL RECTAL TEMPERATURES/
GROUP/CONDITION AND IS NOT AN EXTRACT OF TABLE XVI-1.

TABLE XX
EARLY MORNING RECTAL TEMPERATURES (°F) OF 8 NEGRO
AND 8 WHITE INDIVIDUALS (BEFORE RISING: 0500 HOURS)

	1	2	3	4	PAIR 5	6	7	8	MEAN
NEGRO	97.92	97.50	97.12	97.12	97.88	97.11	97.15	97.82	97.45
WHITE	97.03	97.74	97.62	97.45	97.12	97.24	97.34	97.66	97.40
DIFFERENCE*	+0.89	-0.24	-0.50	-0.33	+0.76	-0.13	-0.19	+0.16	+0.05

*+ INDICATES HIGHER RECTAL TEMPERATURE FOR THE NEGRO.

- INDICATES HIGHER RECTAL TEMPERATURE FOR THE WHITE.

TABLE XXI
A COMPARISON OF MEAN BODY-COMPOSITION MEASUREMENTS
ON 8 EACH MATCHED NEGROES AND WHITES

MEASUREMENT	NEGRO	WHITE	DIFFERENCE	SIGNIFICANCE
PERCENT FAT IN THE BODY	5.6	6.0	0.4	NONE
FAT-FREE WEIGHT (KG.)	66.1	67.1	1.0	NONE
STATURE (CM.)	171.5	173.4	1.9	----

TABLE XXII
SUBJECT PROFILE

<u>PAIR</u>	<u>NEGRO</u>		<u>WHITE</u>	
	<u>WEIGHT</u> (KG)	<u>HEIGHT</u> (CM)	<u>WEIGHT</u> (KG)	<u>HEIGHT</u> (CM)
1	72.31	169.5	67.27	168.9
2	73.92	172.6	73.87	169.2
3	64.74	162.8	63.84	172.8
4	66.24	171.5	66.35	172.5
5	57.39	169.9	66.79	173.5
6	70.51	174.9	71.56	175.0
7	68.93	178.2	75.34	179.5
8	88.13	172.3	86.38	175.9
MEAN	70.27	171.5	71.49	173.4

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